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FLORAL BIODIVERSITY AND CONSERVATION STATUS OF THE HIMALAYAN FOOTHILL REGION, PUNJAB

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Abstract

The floral diversity of the Himalayan foothill region including the forests of Bhurban (Bhurban, Patrieta, Santh Anwali), Kamra (Kamra, Jawa, Kotli Satiyan), Bansra Galli (Wildlife Park, upper fenced area), Kathar (Cpt 109, Cpt 112, Cpt 111, Cpt 110), and Tret (Cpt 94-III, Cpt 96, Cpt 93, Cpt 92, Cpt 95, Cpt 97, Cpt 90, Cpt 91, Cpt 94-I) in the Murree region (Punjab) was explored to assess the vegetation structure and conservation status of economically important species. The vegetation was studied by the quadrat method during 2006-9. A total of 248 species belonging to 56 families were recorded from the area, where Poaceae was the largest family with 48 grass species. This was followed by Papilionaceae with 15, Asteraceae with 10, and Euphorbiaceae with 7 species. Species diversity was quite high, which seemed to be highly influenced by topographic characteristics like altitude, slope and aspect. Many areas were invaded by exotic species like *Dodonaea viscosa*, which was the most dominant shrub at lower altitudes. *Carissa opaca* also dominated lower altitudes along with *D. viscosa. Themeda anathera* dominated higher altitudes and steeper slopes among grasses, whereas tussock grasses like *Chrysopogon serrulatus* and *Dichanthium foveolatum* were dominant at lower altitudes along with *Cymbopogon jwarancusa.* Among conifers, *Pinus roxburghii* was recorded from moderate heights, while *P. wallichiana* and *Cedrus deodara* from the highest peaks. Conservation status of many economically important species was overall very poor, which was ascribed to anthropogenic activities and habitat destruction.

Introduction

Murree region falls into the Himalayan foothills or sub-Himalayan tract, with an approximate elevation up to 2200 m above sea level (asl), which came into existence by a rapid uplift in Early Ecocene era by the collision of Eurasian plate with Indian plate (Zeitler, 1985). Murree region can broadly be divided into two distinct zones; the upper region consists of reddish or purplish sandstones, and the lower with grey-coloured sandstones (Riaz *et al*., 2011). The Murree area is quite rich in species diversity, with over 700 plant species have been recorded, many of them are threatened or vulnerable (Ahmad & Javed, 2007). Three major forest types of the region are: i) sub-tropcal pine forest at higher elevations, ii) Himalayan moist temperate forest at very limited area, and iii) deciduous broad-leaved forest at lower hills (Chaghtai *et al*., 1978).

The climate of the area is not uniform, and this is mainly due to huge variation in altitudinal ranges. Summers are mild and winters extremely cold. Higher altitudes (about 1200 m asl or so) receive snow in the winters from December to March, whereas June to middle September receives the heavy rainfalls of monsoon. Under-storey vegetation is relatively dense in these forests, especially where the average rainfall is higher (Siddiqui *et al*., 2010). Hill slopes in the area are moderately steep with slope angles ranging from 30 to 50° (Malik & Farooq, 1996: Qamar *et al*., 2011).

An effective conservation plan cannot be implemented without knowing the status of indigenous plant species, ecology of habitat types, and factors affecting the population of plant species, particularly those of vulnerable and threatened either locally or internationally (Dalsted, 1988; Ahmad *et al.*, 2010, 2011). Flora of the Murree region is currently under heavy pressure like anthropogenic activities, population pressure and grazing pressure, therefore, the present study was conducted to appraise the community structure and conservation status of economically important angiosperm species.

Materials and Methods

Floral diversity of the Himalayan foothill region (Table 1) including forests of Bhurban (Bhurban, Patrieta, Santh Anwali), Kamra (Kamra, Jawa, Kotli Satiyan), Bansra Galli (Wildlife Park, upper fenced area), Kathar (Cpt 109, Cpt 112, Cpt 111, Cpt 110), and Tret (Cpt 94-III, Cpt 96, Cpt 93, Cpt 92, Cpt 95, Cpt 97, Cpt 90, Cpt 91, Cpt 94-I) in Murree (Punjab) were explored to assess the conservation status of economically important species.

Several vegetation surveys were conducted during 2006-9 to evaluate the floral diversity and community structure in the Himalayan foothill region, and assess conservation status of economically important plant species. Quardat method along a transect line was used for vegetation sampling (Fig. 1). A transect of 200 m length was used at each sampling site, where each sampling point was separated by 50 m from the next. Ten quadrats (10 m^2 for trees, 5 m^2 for shrubs and 1 m^2 for herbs and grasses) were laid perpendicularly along a straight line at each sampling point, 5 on each side of the sampling point. Each 10 m^2 quadrat had smaller quadrats i.e., 5 and 1 m^2 at its same corner, where each quadrat was separated by a distance of 10 m^2 from the next quadrat. Five sampling sites were used at each forest block. Plant samples collected were mounted on a voucher specimen and kept in the herbarium of Botany Department, University of Argiculture, Faisalabad, after proper

identification. Flora of Pakistan (Nasir & Ali, 1972-94; Ali & Qaiser, 1995-2007) was followed for the proper identification of all plants collected. Density, frequency and relative cover were recorded for each species and importance values calculated following Hussain (1983) and Ludwig & Reynolds (1988). Conservation status of each species at a specific habitat was assessed on the basis of density at each study site.

Table 1. Plant community and habitat description in the Murree region

Forest type	Forest block	Coordinates (altitude)	Plant community	Habitat description
Bhurban	Bhurban	33°56'26.24N, 73°26'59.48E (2020 m)	*Pinus wallichiana-Cymbopogon jwarancusa*	The highest altitude of Bhurban forest with quite a few coniferous species, fenced protected area
	Santh Anwali	33°51'47.67N, 73°33'52.89E (1172 m)	*Dodonaea viscosa-Cymbopogon jwarancusa*	Lower altitude with dominant shrubs and grasses
	Budinian	33°50'43.37N, 73°34'03.07E (804 m)	*Olea ferruginaea-Dodonaea viscosa*	The lowest altitude with quite a few shrubs species
	Patriata	33°52'02.32N, 73°28'12.05E (1937 m)	*Myrsine africana-Pinus wallichiana*	High altitude dominated by coniferous species and rich under-storey vegetation
Kamra	Kamra	33°48'40.75N, 73°31'36.74E (1494 m)	*Pinus roxburghii-Quercus incana*	Mixed forest of coniferous and broad-leaved trees
	Jawa	33°48'27.18N, 73°32'00.86E (1299 m)	*Dodonaea viscosa-Dichanthium annuletum*	Relatively lower altitude of this forest with invasive *Dodonaea viscosa* along with rich diversity of grasses
	Kotli Sattiyan	33°49'25.92N, 73°30'36.41E (1423 m)	*Pinus roxburghii-Themeda anathera*	Dominant be coniferous and grasses
Bansra Galli	Wildlife Park	33°53'08.51N, 73°21'23.84E (1549 m)	*Pinus roxburghii-Koeleria macrantha*	Dominant vegetation of chir pine and rich flora of herbs and grasses
	Fenced area	33°53'38.05N, 73°22'51.66E (2149 m)	*Pinus wallichiana-Myrsine africana*	Dominant coniferous with shrubby under-storey vegetation
Kathar	Cpt 109	33°52'34.94N, 73°26'40.93E (1742 m)	*Cressa opaca-Dodonaea viscosa*	The highest altitude of Kathar forest with steep slope facing SWW aspect, with dominant shrubs and grasses
	Cpt 112	33°49'40.67N, 73°22'44.62E (1034 m)	*Dodonaea viscosa*	A lower altitude with moderate slope facing SSW aspects and dominant grasses and small shrubs
	Cpt 111	33°51'39.29N, 73°23'56.24E (1157 m)	*Olea ferruginaea-Cressa opaca*	More or less plane area with dominant shrubs
	Cpt 110	33°47'20.26N, 73°18'00.94E (816 m)	*Cressa opaca-Nerium oleander*	The lowest altitude, more or less plane in the valley rich in dominant shrubs
Tret	Cpt 94-III	33°52'27.47N, 73°17'31.48E (1370 m)	*Cressa opaca-Dodonaea viscosa*	Steep slope facing SE aspect, dominated by mixed vegetation of herbs, shrubs and grasses, with few scattered *Acacia modesta* trees
	Cpt 96	33°54'34.97N, 73°14'55.06E (1163 m)	*Dodonaea viscosa*	More or less plain valley, dominated by shrubby vegetation and grasses
	Cpt 93	33°54'13.95N, 73°12'30.55E (1023 m)	*Olea ferruginaea-Cressa opaca*	Valley with slope angle less than 30°. Vegetation more or less similar to that of Cpt 96, but with relatively herbaceous or grassy vegetation
	Cpt 92	33°54'42.13N, 73°20'10.12E (1227 m)	*Cressa opaca-Nerium oleander*	Moderate slope facing NW aspect, domin ated by shrubby species and quite a few mixed grasses
	Cpt 95	33°51'07.78N, 73°15'56.93E (1320 m)	*Dodonaea viscosa*	More or less flat valley, with single dominant shrub *Dodonaea viscosa* and 2 or grasses.
	Cpt 97	33°56'07.47N, 73°17'43.66E (1559 m)	*Themeda anathera*	Moderately steep hills facing southern aspect, dominated by grassy species and few scattered shrubs
	Cpt 90	33°57'00.27N, 73°20'36.26E (1768 m)	*Cressa opaca-Dodonaea viscosa-Themeda anathera*	Moderately steep facing northern aspect, vegetation cover relatively sparse, dominated by few shrubs and grasses
	Cpt 91	33°55'11.86N, 73°24'36.90E (2170 m)	*Olea ferruginea-Cressa opaca*	Steep slope facing NNW aspect, dominated by some trees an d shrubs, along with few grasses. Vegetation cover relatively dense
	Cpt 94-I	33°56'52.39N, 73°22'51.87E (1883 m)	*Dodonaea viscosa-Dichanthium annuletum*	Moderate slope facing SSE aspect, vegetation cover relatively less dense, dominates by few shrubs, grasses and quite a few herbaceous species

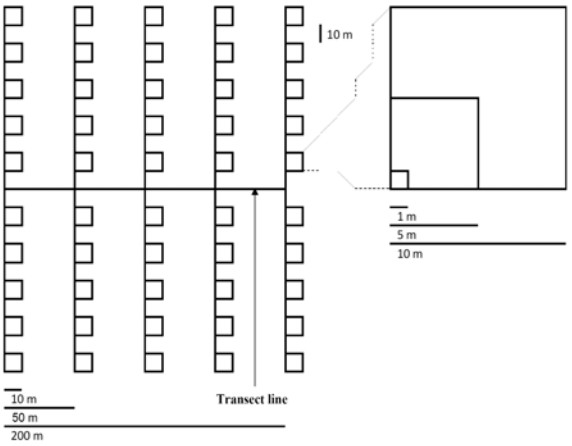


Fig. 1. Layout plan for vegetation sampling in the Murree forests.

Results

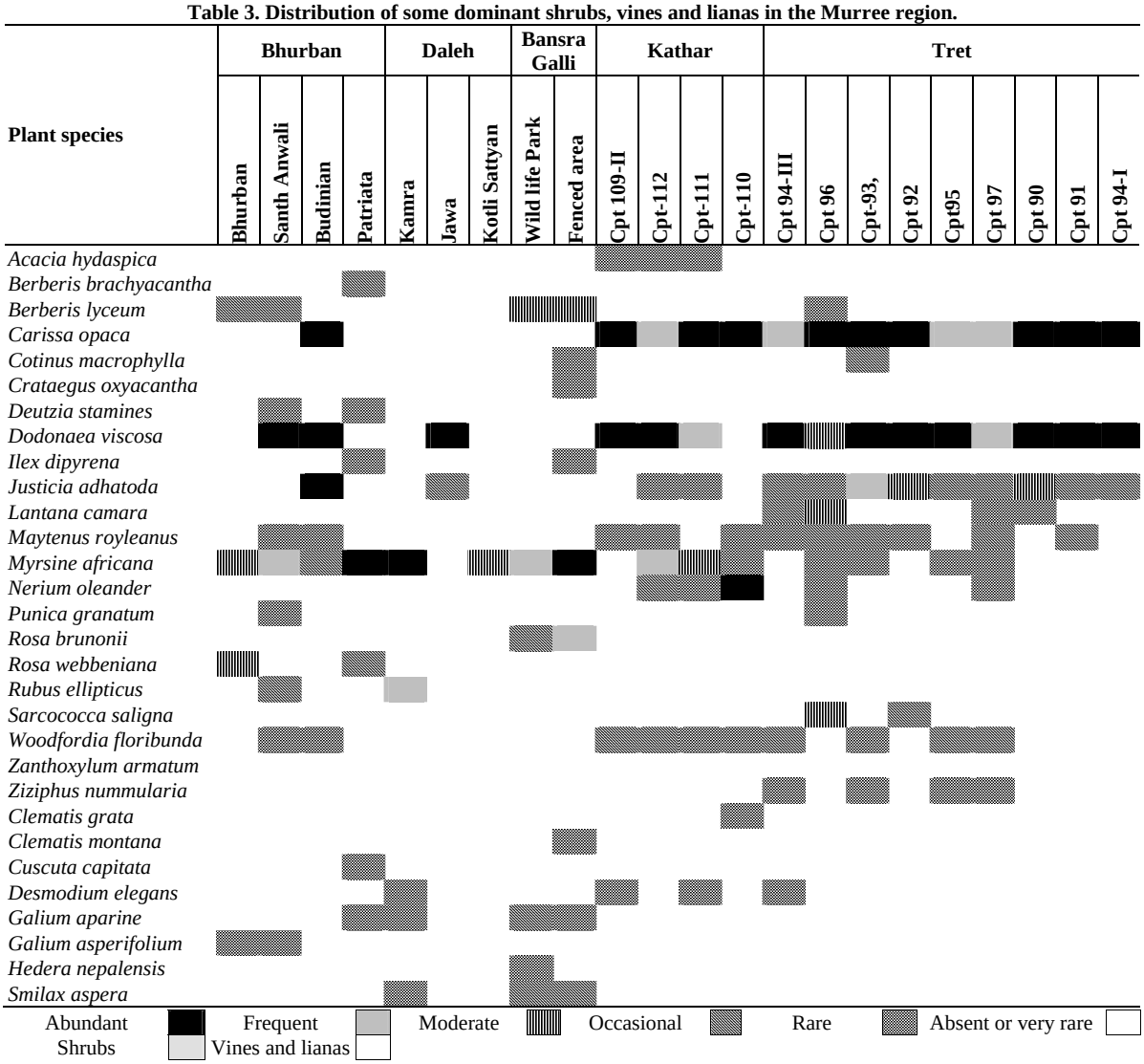
A total of 248 species belonging to 56 families were recorded from the area, where Poaceae was the largest family with 48 grass species. This was followed by Pappilionaceae with 15, Asteraceae with 10, and Euphorbiaceae with 7 species. Two blocks in the Bhurban forest fall under blue pine region, the Burban and Patrieta blocks, whereas, other two in the chir pine region, but the density of the tall trees were extremely low (Table 2). However, both Santh Anwali and Budnian blocks were dominated by shrubby species like *Dodonaea viscosa, Justicaea adhatoda* and *Myrsine africana* (Table 3). Particularly, in the Santh Anwali block, many grasses inhabited the under-storey vegetation, more dominant being *Cymbopogon jawarancusa* and *Aristida mutabilis.* The Budnian block, however, was dominated by shrubs like *Cressa opaca, D. viscosa* and *Justiceae adhatoda* with very few grass species. The Bhurban block was the fenced area and completely protected from anthropogenic activity and life stock invasion. Many coniferous species particularly *Pinus wallichiena* along with *Cedrus deodar* and *Abes pindrow* were recorded from the area. In contrast, Patrieta block was dominated by coniferous as well as tall broad-leaved deciduous trees (*Quercus incana* and *Aesculus hippocestenum*). Quite a few herbs and shrubs were also recorded from the area (Table 4).

Table 2. Distribution of some dominant trees in the Murree region

Plant species	Bhurban				Kamra			Bansra Galli		Kathar				Tret								
	Bhurban	Santh Anwali	Budinian	Patriata	Kamra	Jawa	Kotli Sattyan	Wild life Park	Fenced area	Cpt 109-II	Cpt-112	Cpt-111	Cpt-110	Cpt 94-III	Cpt 96	Cpt-93,	Cpt 92	Cpt 95	Cpt 97	Cpt 90	Cpt 91	Cpt 94-I
Abies pindrow																						
Aesculus hippocastanum																						
Acacia catechu																						
Acacia modesta.,																						
Aesculus indica																						
Ailanthus altissima																						
Albizia odoratissima																						
Bauhinia variegate																						
Cassia fistula																						
Cedrus deodara																						
Cornus macrophylla																						
Cotinus coggygria																						
Dalbergia sissoo																						
Diospyros lotus																						
Ficus bipinnata																						
Lannea coromandelica																						
Mallotus philippensis																						
Olea ferruginea																						
Phyllanthus emblica																						
Phoenix loureiri																						
Pinus roxburghii																						
Pinus wallichiana																						
Pistacia chinensis																						
Pyrus pashia																						
Quercus incana																						
Robinia pseudo-acacia																						
Syzygium cumini																						
Xylosma longifolium																						

Abundant | Frequent | Moderate | Occasional | Rare | Absent or very rare

Table 3. Distribution of some dominant shrubs, vines and lianas in the Murree region.

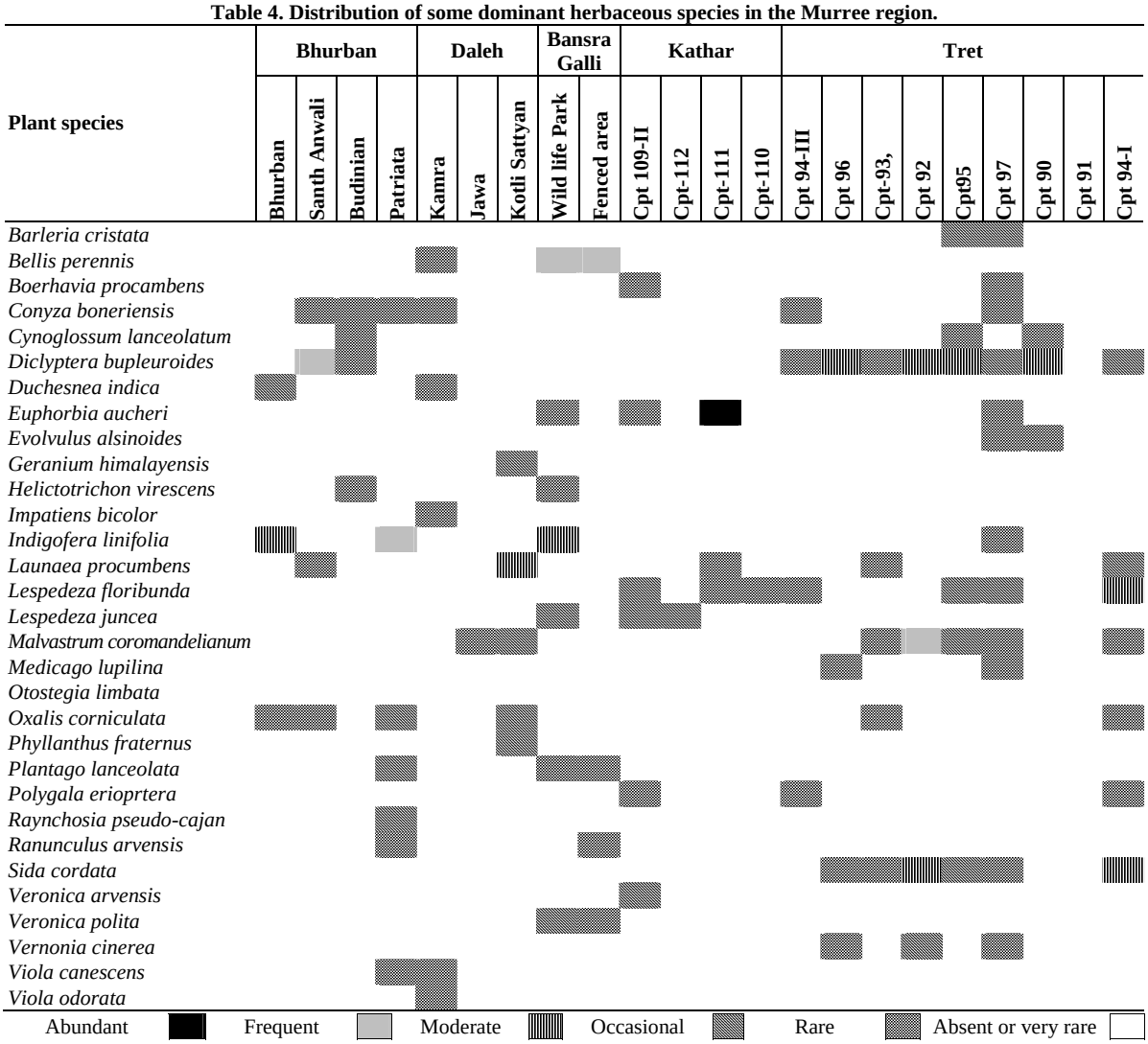


Structure and composition of vegetation was quite different in all three blocks of Kamra forest. *Pinus roxburghii* was the dominant component of above-storey vegetation in Kamra and Kotli Satiyan block, but in Kamra block *P. roxburghii* was shared by *Q. incana*. Kotli Satiyan was dominated by a single shrub, *D. viscosa*, and equally shared by a grass *Dichanthium annulatum* (Table 5). This grass was a dominant componet of Jawa block, however, this habitat was equally dominated by two grasses, *Cynodon dactylon* and *Thamada anathera* along with scattered distribution of two other broad-leaved trees, *Dalbergia sissoo* and *Olea ferruginaea*. Major component of the vegetation in Kotli Satiyan block was herbs and grasses.

The upper area of the Bansra Galli Wildlife Park was fenced and protected, whereas the lower park area was very much exposed to human interference. However, both areas were protected from the activities like wood cutting, etc. Vegetation cover in the upper fenced area was dominated by *P. wallichiana* with a scattered distribution of few conifers like *P. roxburghii* and *Cedrus deodara* (Table 2). Another major tree of the area was *Quisqalis incana*. Under-storey vegetation of this area was quite dense as compared to that of wildlife park area, which was dominated by shrubs like *Myrsine africana* and *Rosa brunonii* (Table 3), herbs like *Bellis perennis* (Table 4) and grasses like *Koeleria macrantha*, *Lolium persicum*, *Arthraxon prionodes* and *Bromus ramosus* (Table 5). The wildlife park area, in contrast, was completely dominated by *P. roxburghii* with a scattered distribution of herbaceous and grass species.

All forest blocks of Kathar forest had more or less similar vegetation structure and species composition. *Cressa opaca*, *D. viscosa* and *O. ferruginaea* were the dominant component of the scrubby vegetation (Table 3). At higher altitude, Cpt 109, density of *O. ferruginaea* was relatively lower as compared to that of the other blocks. The distribution of *D. viscosa*, however, was much lower at the lower altitude, i.e., Cpt 110. *Nerium oleander* was another dominant shrub, which was not recorded at higher altitude of Cpt 109. Ground vegetation was very sparse in all blocks of Kathar forest (Tables 4, 5).

Table 4. Distribution of some dominant herbaceous species in the Murree region.



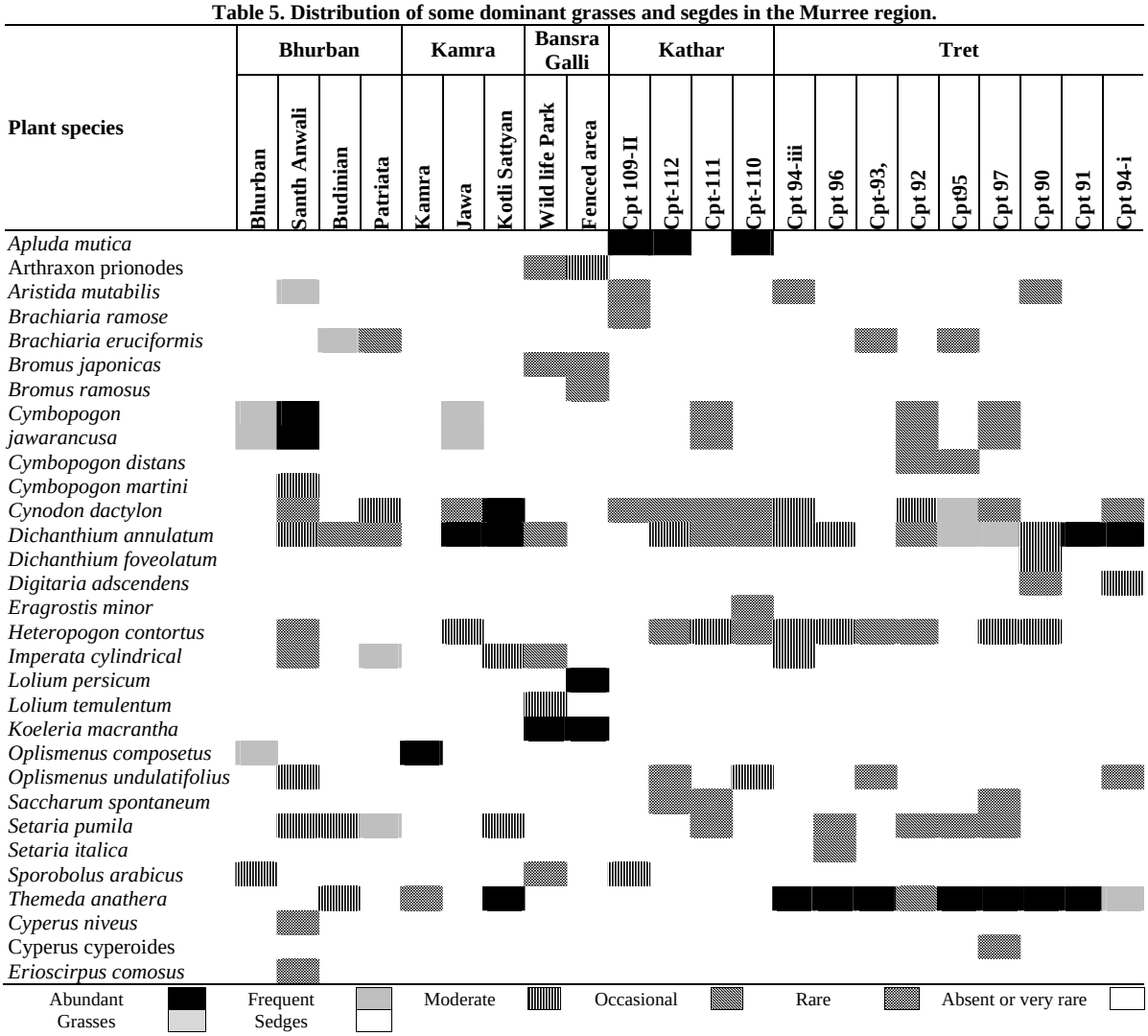
Vegetation structure and composition of the Tret forest was very much similar in all forest blocks, which was dominated by two shrubs, *C. opaca* and *D. viscosa* (Table 3), and a grass species *T. anathera* (Table 5). However, another grass, *D. annulatum* dominated some forest blocks, but overall vegetation structure was variable with the elevation of habitat and slope and aspect of the hills. Two other shrubs, *J. adhatoda* and *M. africana*, were also the major component of the vegetation of the Tret forest.

Discussion

There was a great diversity in the vegetation structure and species composition in the Murree forests, which changes with altitude, slope and aspect of the hills, and type of the above-storey canopy cover. *Acacia modesta* was a component of lower altitude of Kathar and Tret, but the density of this species was relatively lower compared to that of the similar habitats or foothills of the Punjab (Chaudhry *et al*., 2001; Ahmad *et al.*, 2008). However, Hussain *et al*., (1993) reported this species as the most abundant and widely distributed in tropical dry deciduous forest and foothill region. Ahmed *et al*., (2006) reported the dominance of *Acacia modesta* and *Olea ferruginaea* community on the southern aspects of lower hills of Murree, whereas, *O. ferruginaea* on the northern aspect (Ahmed *et al*., 2006; Ahmad *et al*., 2009).

Anthropogenic activities like over-exploitation of plant resources for economic uses, heavy grazing pressure of local livestock, utilization of land for construction and agricultural purposes, and population density are continuously changing the species composition and vegetation structure in the Murree region. This impact is relatively stronger at hotter and lower areas, where a complete dominance of scrub species like *Carissa carandas* and *Dodonaea viscosa* is rapidly replacing tall vegetation, which includes *Pinus roxburghii*,*Acacia modesta* and *Olea ferruginaea*. Similar studies have also been conducted relatively earlier by Naqvi (1976), who reported scattered polulation of a few species like *D. viscosa*, *Otostegia limbata* and *Dicalyptra bupluroides*. Dominance of *D. viscosa* at the hotter and dry sites of the Murree region has been reported by Hussain (1983).

Table 5. Distribution of some dominant grasses and segdes in the Murree region.



Pinus roxburghii completely dominated the forest regions like Bhurban, Kamra and Bansra Galli, however, the highest altitudes by *P. wallichiana.* Few scattered stands of other tall gymnosperms like *Cedrus deodara, Abies pindrow* and *Picea smithiana* were recorded in the Murree region. The density of latter species was extremely low in the Murree forests. Beg (1975) reported the dominance of *P. roxburghii* among coniferous vegetation and *Q. incana* among broad-leaved deciduous trees at the upper Murree region. Ground vegetation comprises *M. africana, Berberis lyceum* and *Hedera napalensis*, as earlier reported by Hussain & Illahi (1991).

Degradation of habitat types in the Murree region is also caused by land sliding and some other anthropogenic factors like deforestation (Neiderer & Schaffner, 1989). This degradation of habitat can be judged by the over growth of less utilizable scrub species and relatively non-palatable grasses, and over-grazing of nutritious and more palatable species (Siddiqui *et al*., 2010). As a result, whole composition of vegetation structure can be disturbed, and a lot of species can fall into vulnerable to threatened class. The present study will certainly help to devise effective management plan, and ultimately extremely helpful in the conservation of indigenous species of the region.

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